



Continuous Monitoring



WORLDWIDE LEADER
Gaseous Fuels, Emissions &
Process Monitoring
Sampling & Laboratory Analysis

One-Stop-Shop for
Gaseous Fuels Analysis

Why Continuous Monitoring

- ▶ Custody Transfer
- ▶ Process Control
- ▶ Risk Management
 - ▶ Health Protective Constituents
 - ▶ Integrity Protective Constituents
 - ▶ Odorization
- ▶ Compliance
 - ▶ Pipeline/Utility RNG Gas Quality Specifications
 - ▶ EPA Renewable Fuel Standard (RFS)

Custody Transfer, Process Control and Compliance

- ▶ Analytes traditionally monitored continuously
 - ▶ Major Gases
 - ▶ Hydrocarbons
 - ▶ H₂S
 - ▶ Moisture (H₂O)

Assess risk associated with accepting third-party RNG and Natural Gas

- ▶ Additional analytes we recommend to monitor continuously
 - ▶ Siloxanes
 - ▶ Mercury
 - ▶ Total & Speciated Sulfur Compounds
 - ▶ Volatile Organic Compounds (VOCs)

Continuous Monitoring Summary

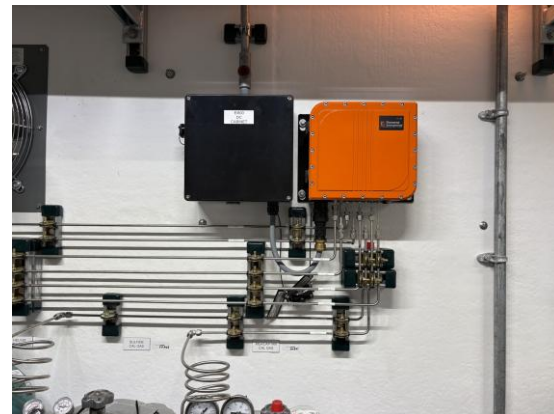
Ei2200					
Ei800 & Ei2800				Ei2300	RA915-AMNG
Major Gases	Hydrocarbons	Sulfur	BTEX	Siloxanes	Mercury
CH ₄	Methane	Hydrogen Sulfide (H ₂ S)	Benzene	TMSOL	Mercury (Hg)
CO ₂	Ethane	Carbonyl Sulfide (COS)	Toluene	L2	
CO	Propane	Dimethyl Sulfide	Ethyl Benzene	L3	
H ₂	i-Butane	Methyl Ethyl Sulfide	Xylenes	L4	
N ₂	n-Butane	Diethyl Sulfide		L5	
O ₂	i-Pentane	Methyl Mercaptan		D3	
H ₂ O	n-Pentane	Ethyl Mercaptan		D4	
H ₂ S	C ₆ +	Tertiary Butyl Mercaptan		D5	
Btu	Hexane	Propyl Mercaptan		D6	
	Heptane	Thiophene		Total Si	
	Octane	Isobutyl Mercaptan			
	C ₉ +	Tetrahydrothiophene (THT)			
		Butyl Mercaptan			



How is the Ei800 Series Different

Ei800 Series Process GC

- ▶ Offers all of the benefits of the traditional GCs, while eliminating all of their limitations.
- ▶ The core difference is a Thermal Conductivity Detector (TCD) sensor technological breakthrough.
 - ▶ Extremely more sensitive
 - ▶ Eliminates dead volume of gas between GC Column and Detector
 - ▶ Replaceable Cartridges



Result

- ▶ Sensitivity increased by Orders of Magnitude
 - ▶ 500 ppb DL
- ▶ Dramatic increase in Speed/Response Time
 - ▶ 30 seconds for complete gas composition analysis
- ▶ One TCD Detector for all compounds
- ▶ Flexible design allows for custom GC Column selection

Beyond the Incredible TCD Detector

- ▶ Multi-Stream Capability
 - ▶ Analyses complete within 15-minute EPA RFS Mandate
- ▶ Explosion-Proof Enclosure
- ▶ Super Fast Analysis
 - ▶ 30 seconds for complete gas composition analysis
 - ▶ Parallel foreflush and backflush analysis
- ▶ Extreme Sensitivity/Accuracy
 - ▶ 500 ppb DL
 - ▶ 0.025% CV
 - ▶ ISO 6976, GPA 2172, ASTM D3588



Ei800 Series Process GC (cont'd)

- ▶ Minimal Carrier Gas Consumption
 - ▶ 5 ml/min. during analysis
- ▶ Low Power Requirements
 - ▶ 10 W power consumption
 - ▶ No AC required (24 VDC)
- ▶ Compact Design
 - ▶ 11.4 x 10.2 x 4.8"
 - ▶ Weighs less than 30 lbs
- ▶ Easy to Maintain
 - ▶ No tubes or capillaries
 - ▶ Very robust design
 - ▶ Replaceable cartridges



Ei800 Series Process GC (cont'd)



- ▶ Exchangeable Cartridge
- ▶ Standalone Operation
 - ▶ 24/7 autonomous operation without PC
 - ▶ PC connection for setup and support
- ▶ Integrated Data Processing & Communication
 - ▶ Integrated processor generates data
 - ▶ Communication via MODBUS
- ▶ Configurable Gas Ports
 - ▶ 2 Carrier Gas ports
 - ▶ 4 Sample or Calibration Gas ports
- ▶ Flexible Design
 - ▶ Customize up to 4 GC units
 - ▶ Ovens with GC Columns and Injector/Detector Chips



One Analyzer for All of Your Needs

- ▶ RNG Interconnection Compliance
- ▶ Biogas/RNG Process Monitoring
 - ▶ Inert Coating for High H₂S
 - ▶ Pump Module for Low Pressure
- ▶ EPA Renewable Fuel Standard (RFS) Compliant
- ▶ Natural Gas
 - ▶ Custody Transfer
 - ▶ Total Sulfur (D6228)
 - ▶ Trace Oxygen
 - ▶ Trace Moisture
 - ▶ BTEX



Ei2800 Series Integrated Solution

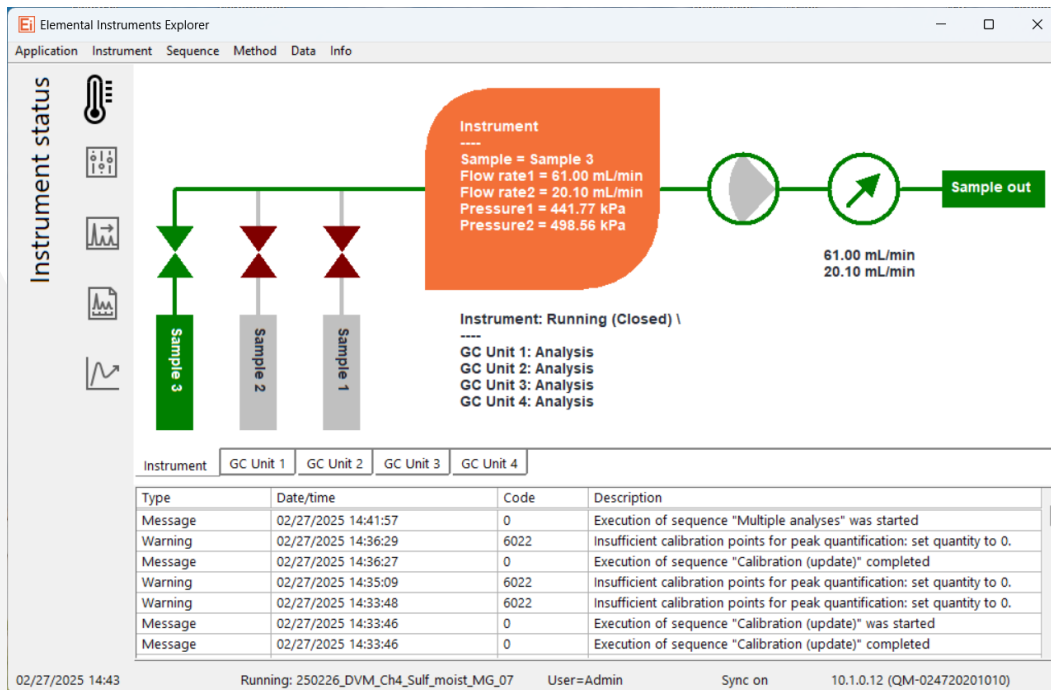


- ▶ **Base Hardware**
 - ▶ Ei800 Process GC
 - ▶ Junction Box
- ▶ **Sample Conditioning**
 - ▶ Probe(s)
 - ▶ Pressure Regulators
 - ▶ Sample & Exhaust Lines
 - ▶ Enclosure
 - ▶ Genie Membrane Filters
 - ▶ Pressure Regulator/Gauges
 - ▶ Flowmeters with Needle Valves
 - ▶ Moisture Control Tubing (Raw Biogas)
 - ▶ Pump Module (< 3 psi)
 - ▶ Cooling Fan & Cabinet Heater
 - ▶ Optional Air Conditioner



Ei800/2800 GC Explorer Software

Ei Explorer Software lets you perform all manipulations



Ei2300 Siloxane Monitoring System

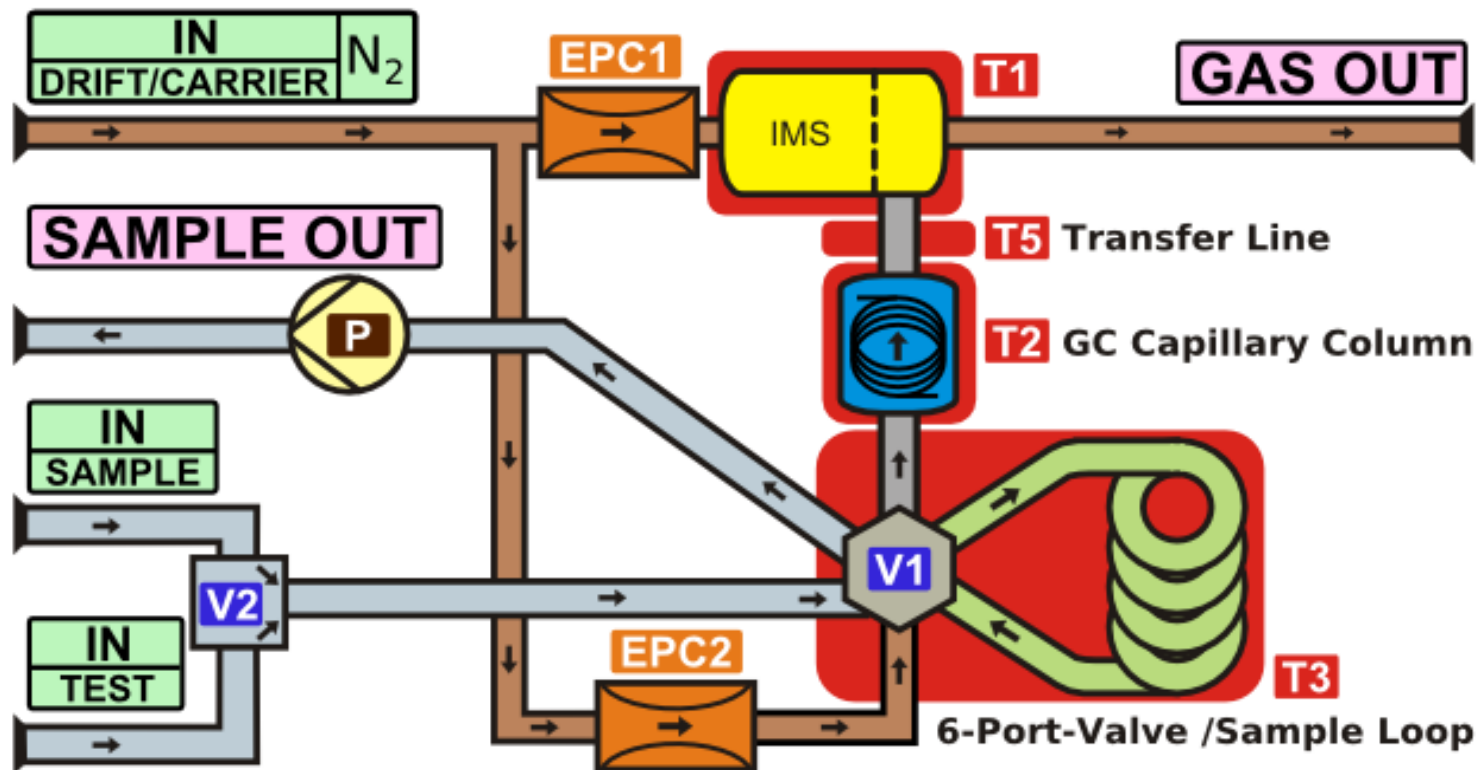


ASTM D8455

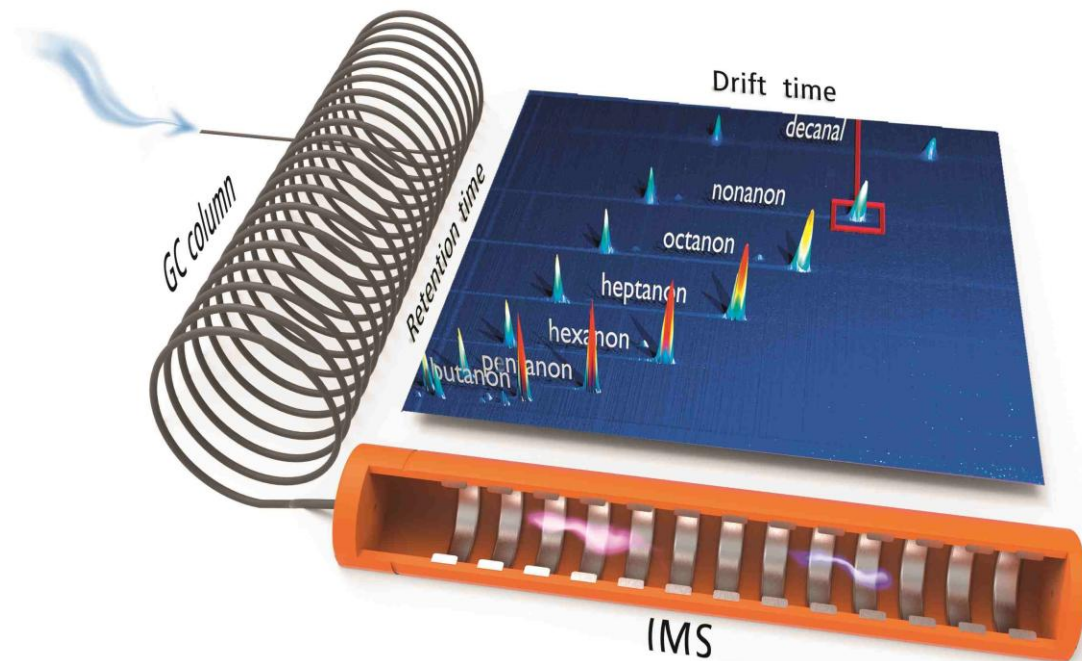


ISO 2613-2

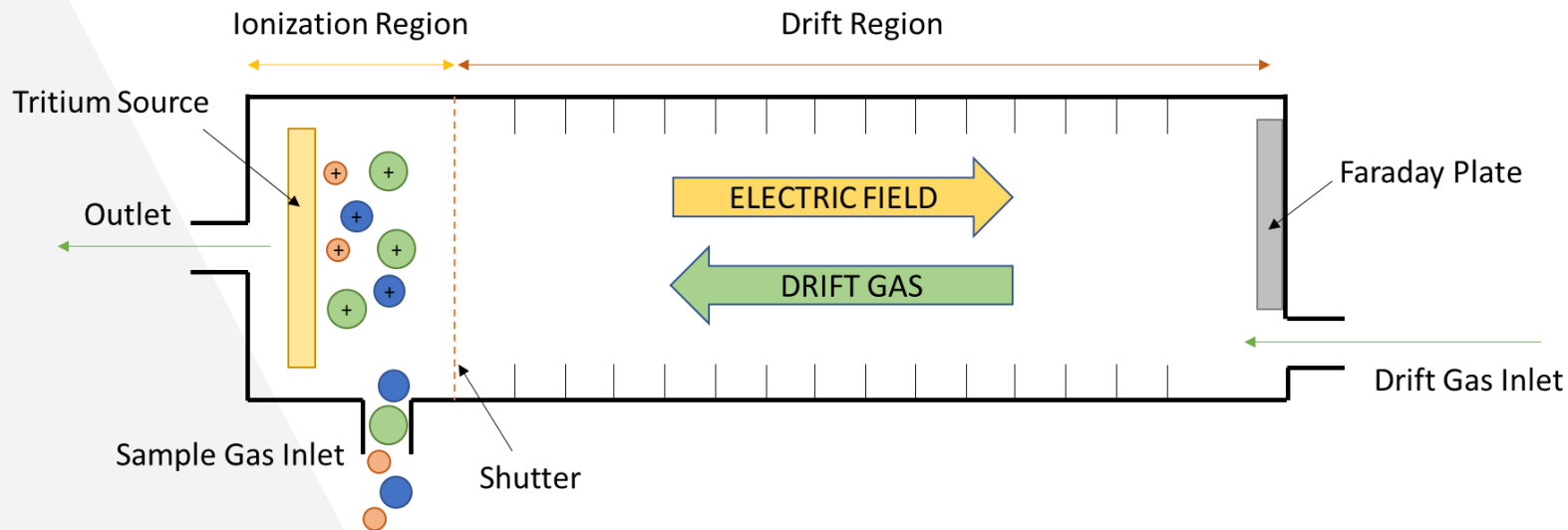
GC-IMS Two-Stage Separation



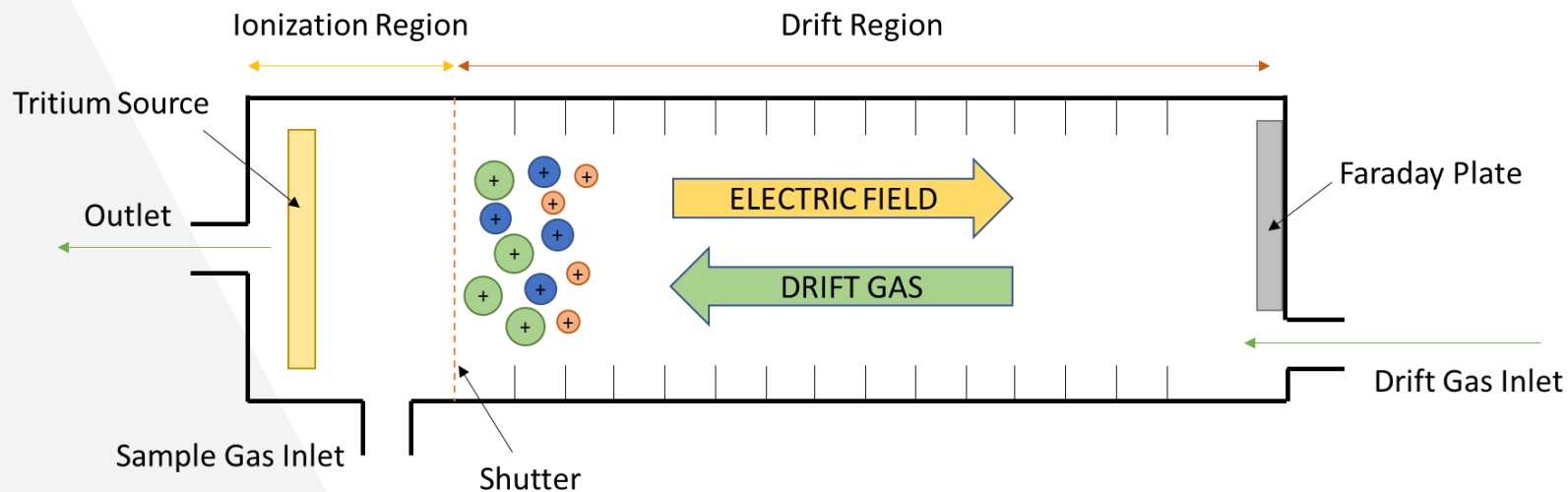
GC Retention Time vs. IMS Drift Time



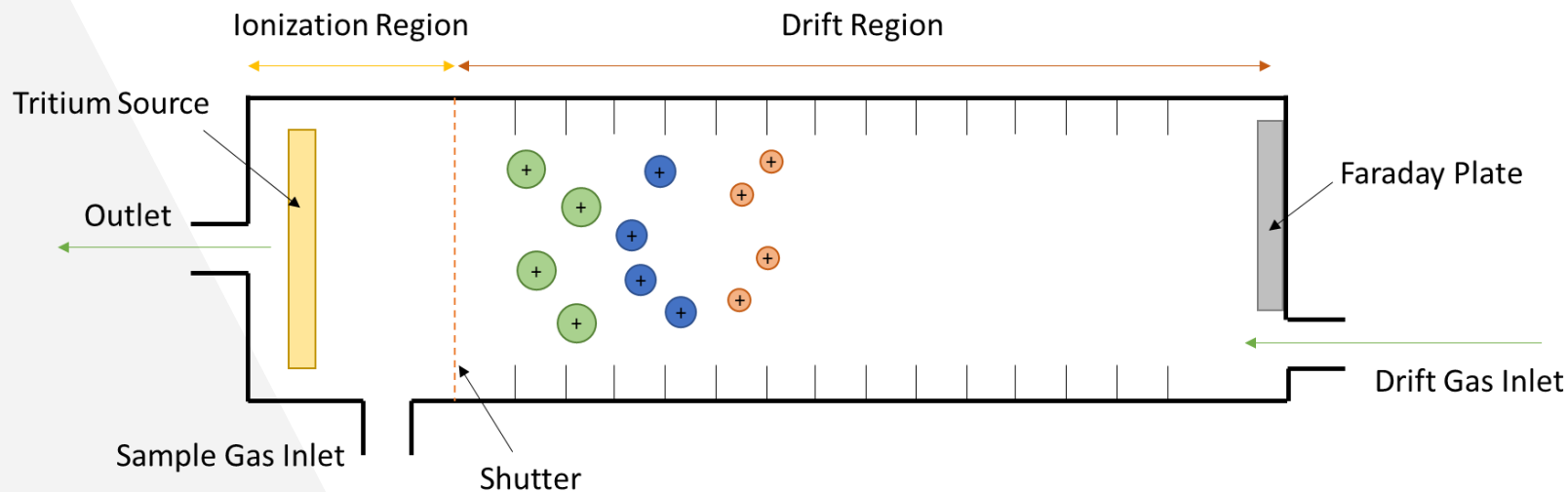
Ion Mobility Spectrometer (IMS)



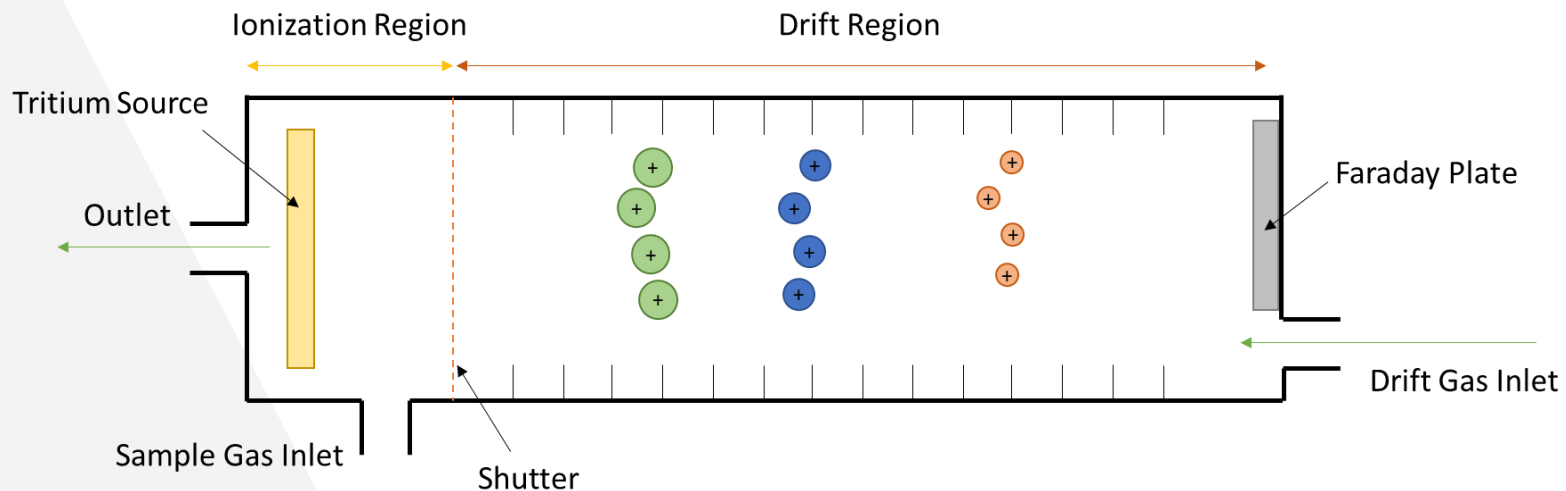
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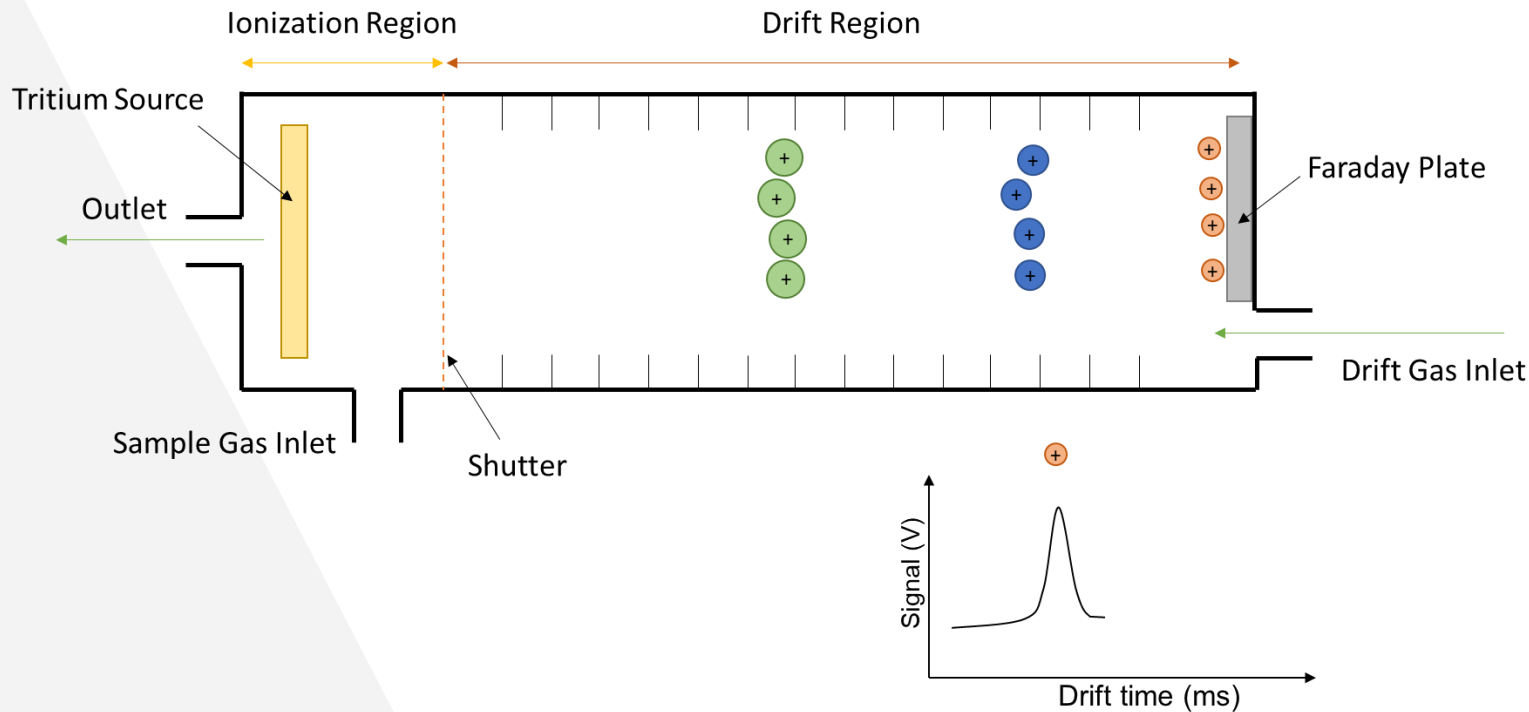
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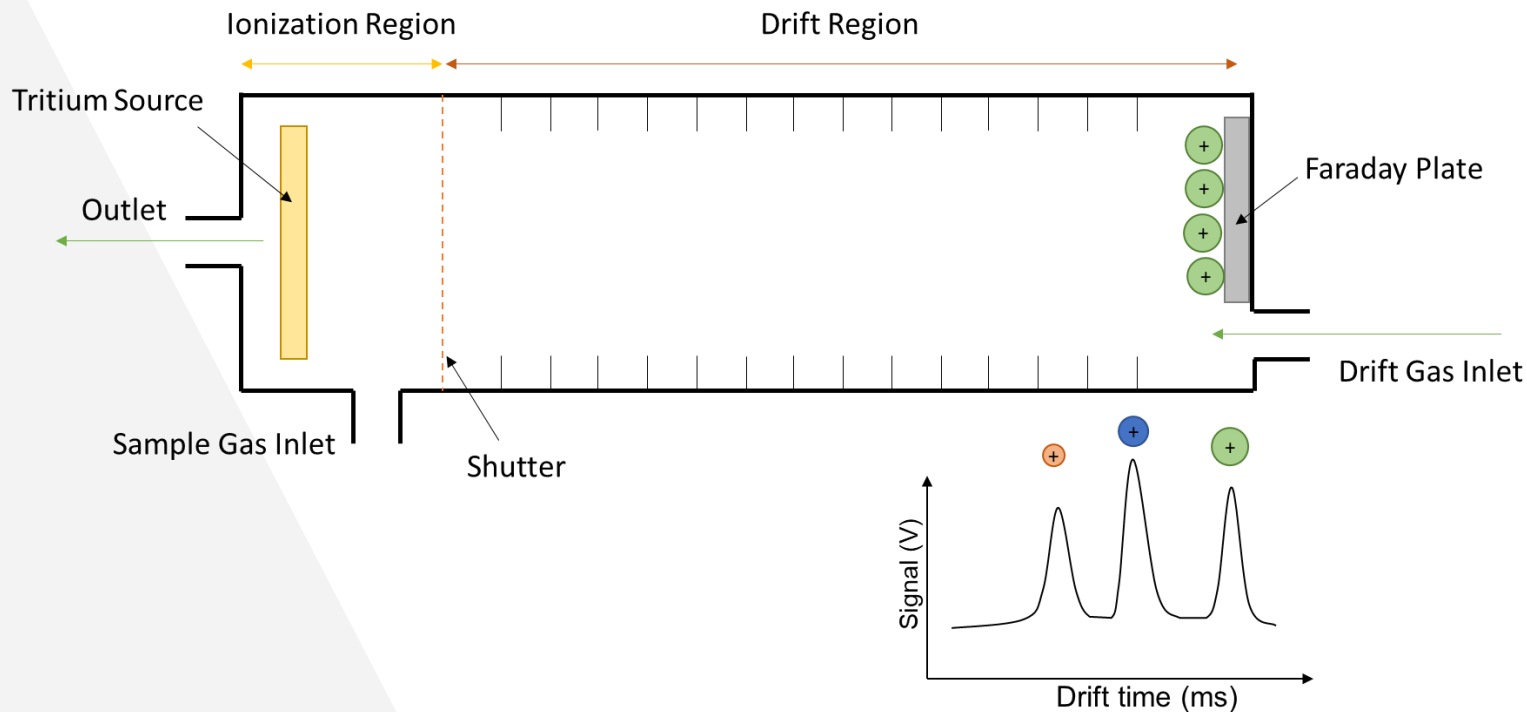
Ion Mobility Spectrometer (IMS)



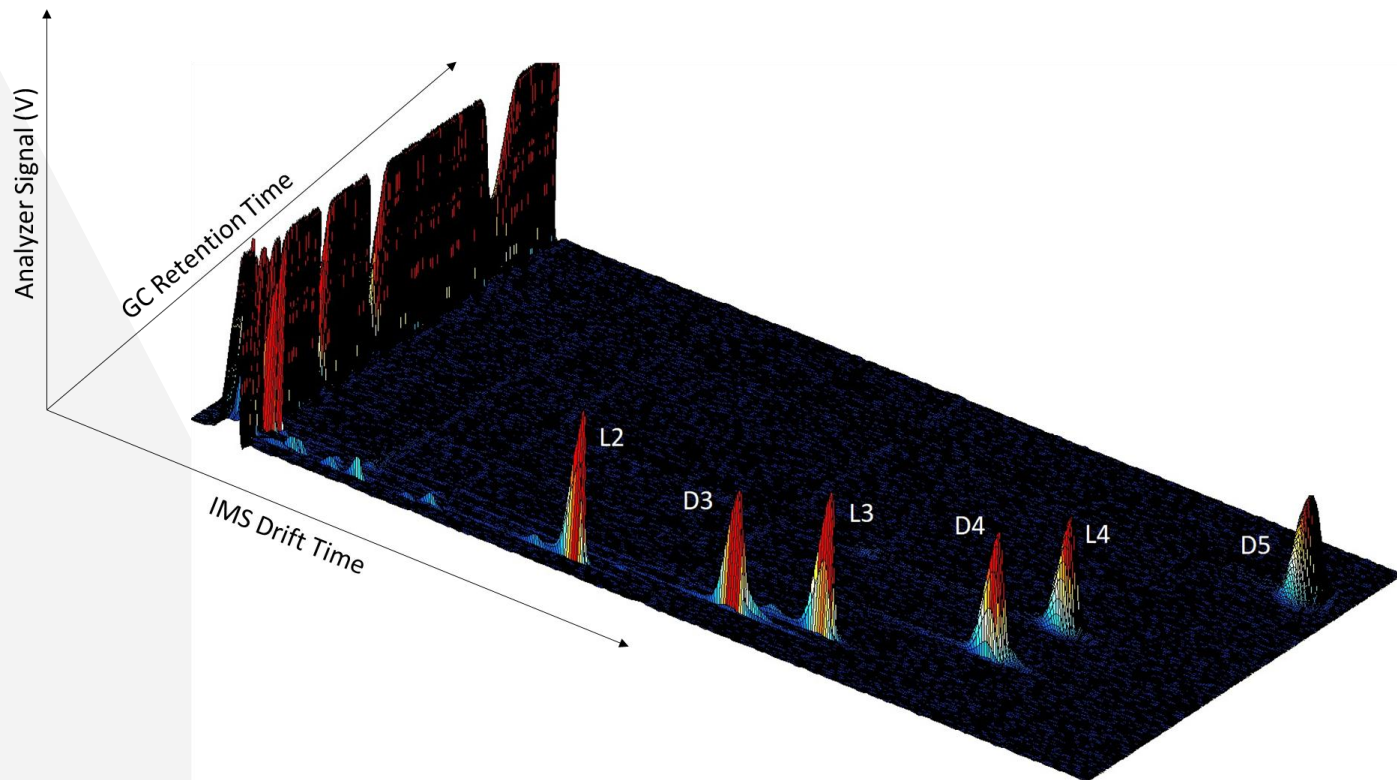
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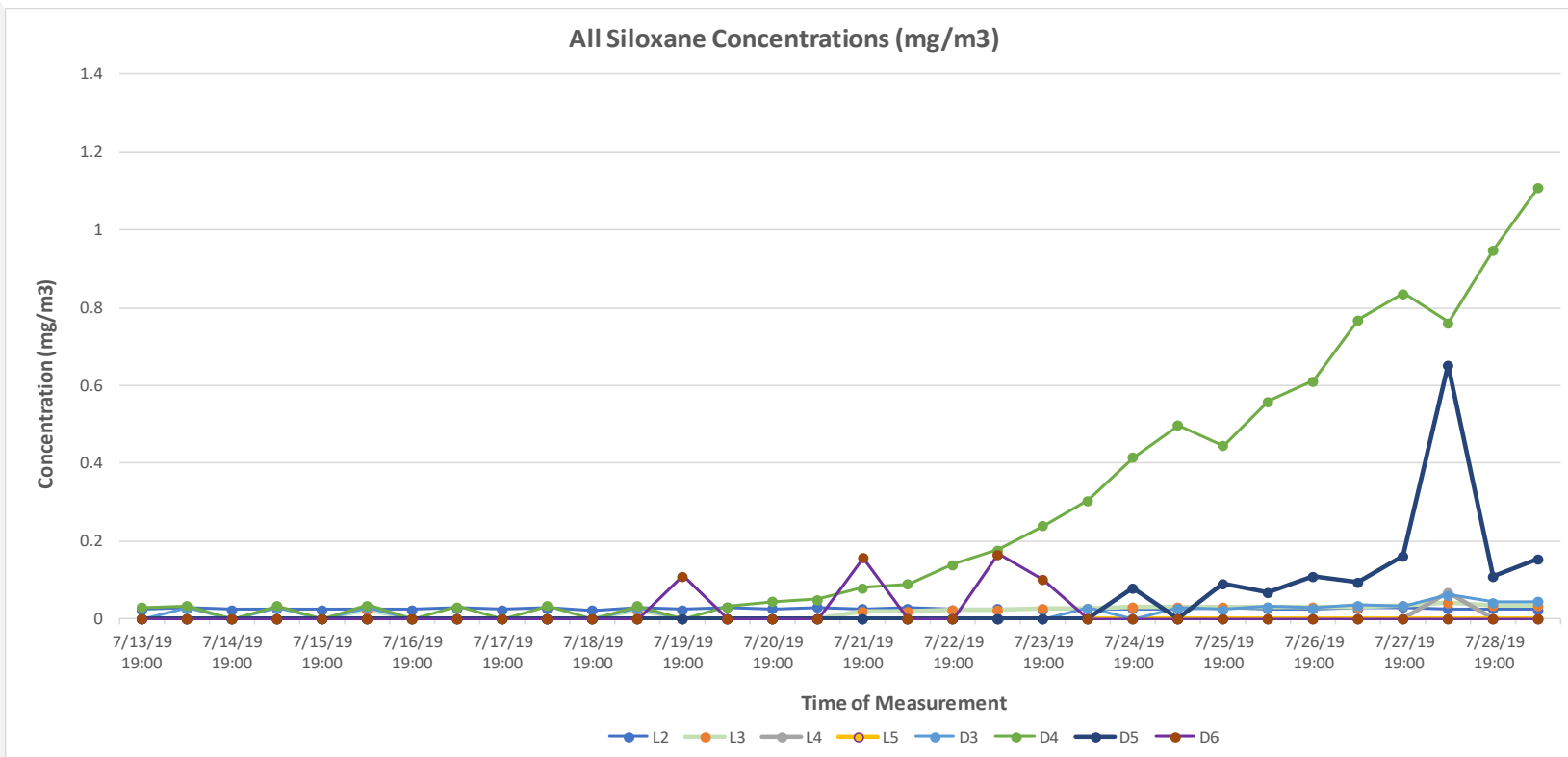
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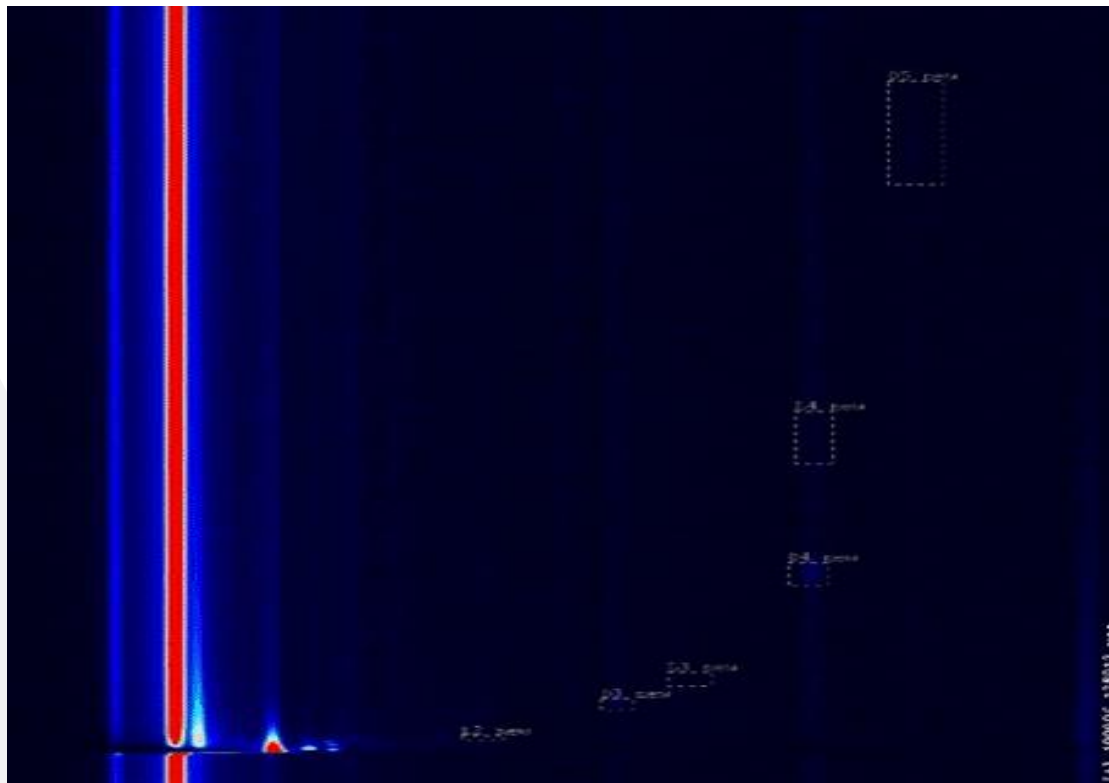
3-Dimensional Representation



Landfill Monitoring Data - Breakthrough



Landfill Monitoring Data - Breakthrough



Calibration & Limits of Quantification

Ohio Lumex Proprietary Calibration Procedure <i>Typical Limits of Quantitation (LOQ) [1 mL Loop] *</i>		
Species	LOQ (mg Si/M ³)	LOQ (ppb)
(TMSOL) Trimethylsilanol	0.005	1.2
(L2) Hexamethyldisiloxane	0.005	0.8
(L3) Octamethyltrisiloxane	0.006	0.6
(L4) Decamethyltetrasiloxane	0.006	0.5
(L5) Dodecamethylpentasiloxane	0.006	0.4
(D3) Hexamethylcyclotrisiloxane	0.006	0.7
(D4) Octamethylcyclotetrasiloxane	0.007	0.6
(D5) Decamethylcyclopentasiloxane	0.007	0.5
(D6) Dodecamethylcyclohexasiloxane	0.008	0.4

* Example may vary by application

AMNG Mercury Monitoring System



Explosion Proof



General Purpose

AMNG Mercury Monitoring System



- ▶ The AMNG Mercury Monitor is designed for continuous, online measurement of mercury in natural gas or other gaseous fuels, including RNG.
- ▶ Zeeman Background Correction technology corrects for interferences in the gas stream, allowing measurement of very low mercury concentrations.
- ▶ Automatic zero and span corrections allow for stable long-term operation with low maintenance requirements.
- ▶ Configuration options:
 - ▶ Explosion-Proof enclosure
 - ▶ General-Purpose 19" rack-mount enclosure

▶ **Key Features**

- ▶ No carrier gases required
- ▶ No zero or span gases required
- ▶ Automatic zero drift correction
- ▶ Automatic span drift correction
- ▶ Long-term calibration stability
- ▶ Zeeman Background Correction
- ▶ Communication via MODBUS or 4-20 mA
- ▶ Direct continuous measurement
- ▶ Low detection limit (0 – 5 ng/m³)
- ▶ Wide measurement range (0 – 25,000 ng/m³)
- ▶ Low maintenance

AMNG Mercury Monitoring System



- ▶ **Low Maintenance**
 - ▶ No carrier gases required
 - ▶ No zero or span gases required
 - ▶ Mercury cell inside spectrometer
 - ▶ Consumables
 - ▶ Zero filter
 - ▶ Recommend replace every 6 months to a year
 - ▶ Particulate filter on inlet
 - ▶ Recommend replace every year



AMNG Mercury Monitoring System



Technical Specifications		
Measurement Range*	Treated Gas 0 – 25,000 ng/m ³	Raw Gas 0 – 250,000 ng/m ³
Detection Limit**	Treated Gas 0 – 5 ng/m ³	Raw Gas 10 – 50 ng/m ³
Averaging Interval	5 min	
Zero Drift Correction	Automatic	
Span Drift Correction	Automatic	
Sample Requirements		
Gas Pressure	Atmospheric ± 30% (Pump available if sample not under pressure)	
Flow Rate	4 – 10 LPM	
Gas Humidity	Dew Point < +10°C (+50°F)	
Gas Temperature	-20°C (-4°F) to +40°C (104°F)	
Data Output		
Communication Ports	2 x LAN, Isolated 4 – 20 mA	
Status Outputs (via Modbus)	MEASURING; ZERO CONTROL; CALIBRATION; SERVICE; FAILURE	
Operating Conditions		
Temperature	+20 ± 2°C (+68 ± 3.6°F)	
Relative Humidity	<98% at 35°C (+95°F)	
Power Requirements	110/240 V, 50/60 Hz; 120 VA	
Dimensions (Explosion-Proof Encl.)	740 x 584 x 251 mm (29 x 23 x 10 in)	
Weight (Explosion-Proof Encl.)	92 kg (203 lbs)	

▶ Applications

- ▶ Mercury monitoring in Natural Gas
- ▶ Mercury Removal Units (MRUs)
- ▶ Liquefied Natural Gas (LNG) Terminal
- ▶ Renewable Natural Gas (RNG) monitoring
- ▶ Petroleum refinery process gas
- ▶ Others



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H ₂ S	C ₆ +	Tertiary Butyl Mercaptan		D5	
Btu	Hexane	Propyl Mercaptan		D6	
	Heptane	Thiophene		Total Si	
	Octane	Isobutyl Mercaptan			
	C ₉ +	Tetrahydrothiophene (THT)			
		Butyl Mercaptan			



One-Stop-Shop for Gaseous Fuels Analysis



▶ **Analyzers and Equipment**

- ▶ Ei800/2800 Biogas/RNG/NG Monitoring System
- ▶ Ei2300 Siloxane Monitoring System
- ▶ Ei2200 RNG Monitoring System
- ▶ RA915-AMNG Mercury Monitor
- ▶ Sampling Equipment, Supplies and Guides

▶ **Analytical Laboratory (NELAP, ISO Accredited)**

- ▶ Laboratory Analysis
- ▶ Methods Development

▶ **Onsite Field Services**

- ▶ Onsite Sample Collection (Certified Field Technicians)
- ▶ Commissioning & Start Up
- ▶ Training, Support & Service

Experience Matters
Trust the Experts



Bennett Rubin

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ASTM D03 Gaseous Fuels Committee

- ▶ Chair D03.01
Collection and Measurement of Gaseous Samples
- ▶ Vice Chair D03.06
Analysis of Constituents in Gaseous Fuels